

Mansoura University
Faculty of Pharmacy
Dept. of Microbiology

Practical Parasitology

Delivered By
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Faculty of Pharmacy

CONTENTS

Protozoans: Sarcodines, Flagellates, and Ciliates

Parasites may be one-celled animals like protists (protozoans) or multicellular animals (metazoans). Parasitology courses include the study of protozoans, helminths (parasitic worms), and parasitic arthropods such as lice, mites, and ticks. Helminths and arthropods are metazoans. Classical parasitology courses are slanted toward the zoological aspect, which emphasizes the parasite rather than the effect of the parasite on the host. This module will be a medically oriented presentation of a few protozoan-caused diseases.

Protozoans are classified according to the type of motility they exhibit or their mode of reproduction. The following is a simplified classification:

Kingdom: Protista
- Phylum 1: Sarcodina—locomotion by means of pseudopods.
- Phylum 2: Zoomastigina—locomotion by means of flagella.
- Phylum 3: Ciliophora—locomotion by means of cilia.
- Phylum 4: Apicomplexa—multiply by spore formation; move with undulations due to myonemes and fibrils; complex life cycle.

Table 1 shows the free-living (nonparasitic) as well as the parasitic representatives that you will study in each class. This table, along with Figure 1 summarizes the clinical and laboratory significant characteristics of each parasite. From Table 1 , you can see why the specimen of choice to study parasitic protozoans is not readily available for classroom use. It would be most difficult to have a fresh stool specimen containing *Entamoeba histolytica* or *Balantidium coli* and a vaginal discharge of *Trichomonas vaginalis* available when you need it. Therefore, it will be necessary for you to study the parasitic, disease-producing protozoans from stained smears. For the same reason, you will be using the nonparasitic representatives for the study of living forms of each phylum.

The parasitic sarcodines, flagellates, and ciliates are motile in a freshly obtained specimen that is still warm from body heat. This motile form of the protozoans is called the *trophozoite*. As the specimen dehydrates in the bowel or after leaving the host, the trophozoite becomes inactive, rounds up, forms thick walls, and is then called a *cyst*. It is the trophozoite that causes the pathological condition in the host. Most of the stained smears that you will be examining of the parasitic protozoans will be of the cyst stage, with the exception of *Trichomonas vaginalis* and

TABLE 1 Summary of Significant Characteristics of Protozoans

Phylum	Classification characteristics	Free-living nonparasitic representative	Parasitic representative	Portal of entry or mode of entry	Parasitic condition in humans	Specimen of choice for identification of parasite
Sarcodina	Locomotion by means of pseudopods	*Amoeba proteus*	*Entamoeba histolytica*	Ingestion of cysts	Amoebic dysentery	Fresh stool
Zoomastigina	Locomotion by means of flagella	*Euglena gracilis*	*Trichomonas vaginalis*	Fecal contamination of the vagina, sexual intercourse	Vulvovaginitis	Vaginal discharge Urethral discharge
			Giardia lamblia	Ingestion of cysts	Enteritis and diarrhea	Fresh stool
			Trypanosoma gambiense or any trypanosomal species	Bite of insect vector (tsetse fly)	African sleeping sickness	Blood smear
Ciliophora	Locomotion by means of cilia	*Paramecium caudatum*	*Balantidium coli*	Ingestion of cysts	Recurrent diarrhea alternating with constipation	Fresh stool
Apicomplexa (Haemosporina)	No locomotor organelles; multiply by forming spores; complex life cycle	None	*Plasmodium* sp.	Bite of insect vector	Malaria	Blood smear

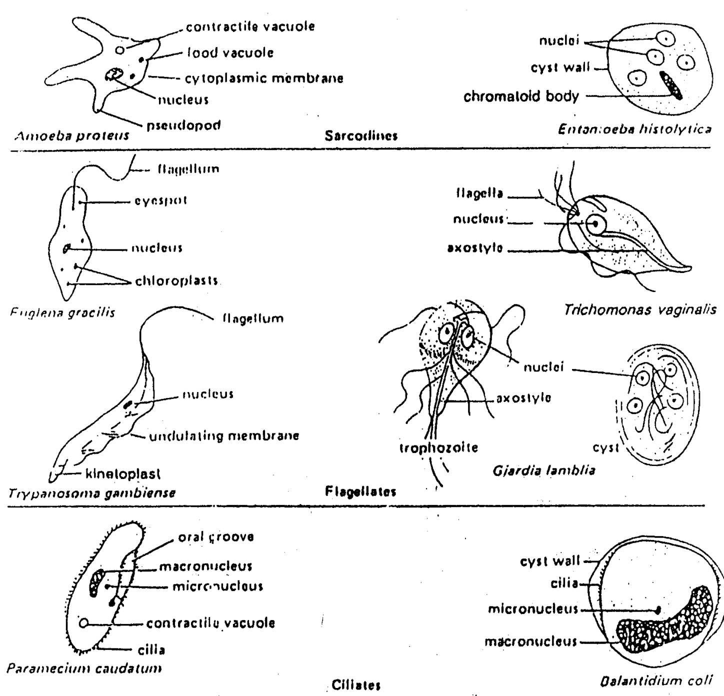


FIGURE 1
Identifying structures of representative protozoans.

ACTIVITIES

Activity 1: Phylum: Sarcodina (Rhizopoda)

1. Make a wet mount of the trophozoite stage of the nonparasitic, living *Amoeba proteus.*

2. First search the wet mount preparation with your low-power objective to locate an amoeba.
   - Under low power, an amoeba looks like a mass of granular material. Sometimes it is necessary to examine more than one wet mount before finding an amoeba.
3. Once you have located an amoeba, move the organism to the absolute center of the microscope field before turning to your high-power objective.
4. Look for forming pseudopods, streaming protoplasm, nucleus, contractile vacuole, and inclusions, as shown in Figure 1 .
5. On the worksheet, make a drawing of the trophozoite, using arrows to show the direction of the movement of protoplasm. Label the internal structures that you were able to see.
6. Next examine a stained smear of the parasitic representative of this class, *Entamoeba histolytica.* Refer to Figure 1 for identifying structures.
7. Draw as much detail of the cysts as possible using your oil-immersion objective.
8. Write a short description of the disease caused by *E. histolytica.*

Activity 2: Phylum: Zoomastigina

1. Make a wet mount of the trophozoite stage of the living *Euglena* by adding one drop of culture to one drop of Protoslo. *Euglena* move very rapidly by means of their whip-like flagella.
   - The Protoslo slows down the organisms so you will be able to keep them in your microscope field.
   - Except for the addition of the drop of Protoslo, make the wet mount the same way as you did in Activity 1.

2. Observe the wet mount with the high-power objective. Refer to Figure 1 for the structures you are likely to see. Look especially for the flagellum and chloroplasts.
   - *Euglena* is thought to be a transitional organism linking the plant and animal kingdoms since it has characteristics of each.

3. *Euglena* are small, so draw what you see on your worksheet.

4. Review Table 1 again for the most common or most famous flagellates. Using your oil-immersion objective, examine the stained slides of the flagellates that you have available.
   a. Make drawings of the stained *Trichomonas vaginalis* trophozoites, along with a written description of the condition that they cause.
      - See Figure 1.
   b. Make drawings of the stained cysts and trophozoites of *Giardia lamblia*, and write a brief description of the disease they cause.
      - Refer to Figure 1 for identifying structures.
      - Note the eye-like appearance of the nuclei.

      Giardiasis occurs more often in children than in adults.
   c. Make a drawing of a blood smear of *Trypanosoma gambiense* or another *Trypanosoma* species, and accompany the drawing with a written description of the disease.

Activity 3: Phylum: Ciliophora

1. Make a wet mount of the living *Paramecium* culture using Protoslo as you did in Activity 2.
2. Examine the wet mount preparation for the characteristic structures and movements of this nonpathogenic representative of the ciliated protozoans.
   - See Figure 1 for characteristic structures.
3. Make a drawing of the organism, and label the structures that you see.
4. Next study the stained smears of the cysts of *Balantidium coli*, the only parasitic ciliate of humans.
   - This is the largest of parasitic protozoans.
5. Make a drawing of a *B. coli* cyst, along with a written description of the disease.

When you have completed the drawings and the written descriptions of activities in this module, take the post test. Repeat this module if necessary in order to complete the post test to your satisfaction.

FORMULA FOR REAGENT

10% METHYL CELLULOSE

methyl cellulose	10 g
tap water	100 ml

Heat tap water to 85°C. Add methyl cellulose powder. Cool the mixture in an ice bath to approximately 5°C, stirring rapidly and constantly. This solution is stable at room temperature. Store in a tightly closed screw-cap bottle.

Dilute this stock solution 1:5 for use in protozoan wet mounts. Add water slowly and stir constantly as you make this dilution to prevent the formation of lumps.

Name ______________________

Lab Section ______________________

PROTOZOANS: SARCODINES, FLAGELLATES, AND CILIATES

Activity 1
Sarcodina

Amoeba proteus
trophozoite

Entamoeba histolytica
cyst

Describe disease caused by *E. histolytica.* ______________________

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Activity 2
Zoomastigina

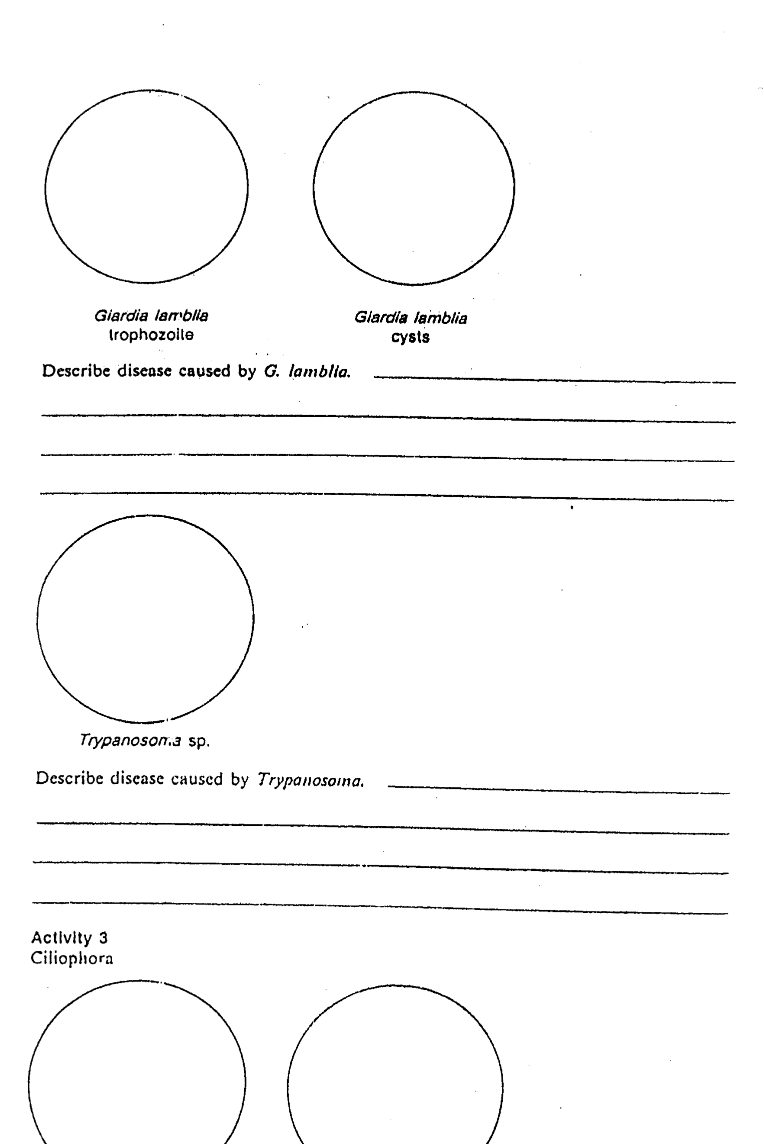
Euglena sp.
trophozoite

Trichomonas vaginalis
trophozoite

Describe condition caused by *T. vaginalis.* ______________________

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Giardia lamblia
trophozoite

Giardia lamblia
cysts

Describe disease caused by *G. lamblia.* ______________________________

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Trypanosoma sp.

Describe disease caused by *Trypanosoma.* ______________________________

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Activity 3
Ciliophora

Paramecium caudatum
trophozoite

Balantidium coli
cyst

Describe disease caused by *B. coli.* ____________________________________

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Protozoans: Haemosporina

The organisms in phylum Apicomplexa are all obligate parasites; therefore, there are no free-living representatives for you to examine. Plasmodium (suborder Haemosporina), the malaria-causing protozoans, are the representative parasites that you will study. The Haemosporina have a complex life cycle requiring two very different hosts. They have a sexual cycle, in which spores are formed, and an asexual cycle. The sexual cycle takes place in the gut and abdominal wall of the female of some species of mosquito in the genus *Anopheles.* The asexual cycle takes place in the liver and erythrocytes of humans and causes the symptoms of the disease. At least five species of the genus *Plasmodium* cause malaria. Some examples are *P. vivax, P.*

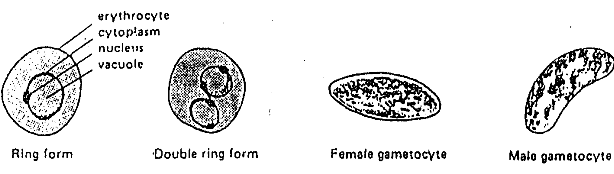


FIGURE 1
Stages of the Plasmodium life cycle most commonly seen in blood smears. (Diagrammatic. Use photographic plate for accuracy.)

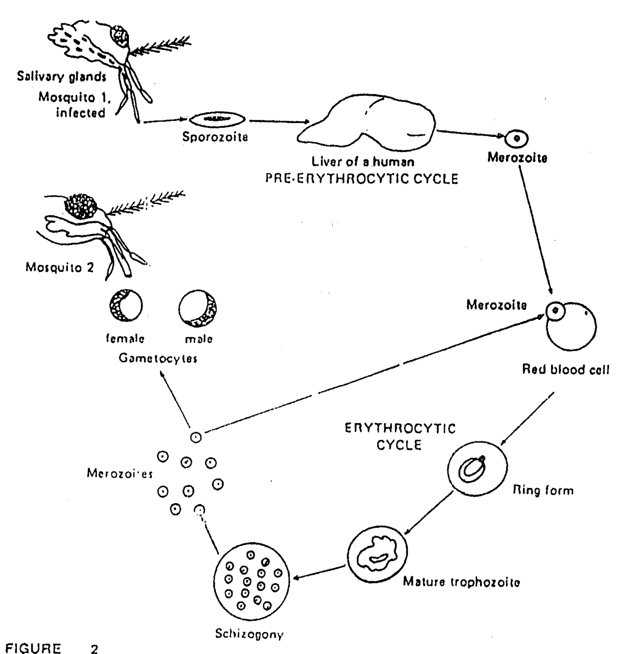


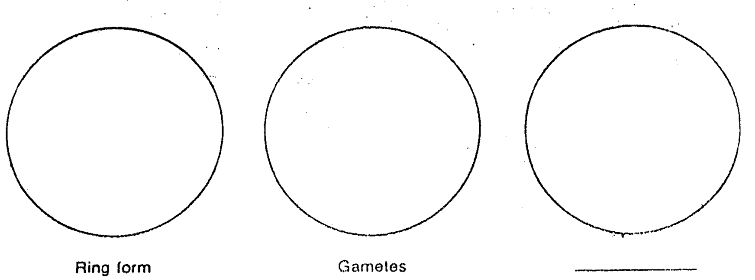
FIGURE 2
Asexual cycle in humans.

Name ______________________

Lab Section ______________________

PROTOZOANS: HAEMOSPORINA

Examination of Malaria Parasite in Stained Blood Smears



Ring form　　　Gametes　　　__________

ACTIVITY

Examination of the Malaria Parasite in Stained Blood Smears

1. Inspect a stained blood smear for the different stages of the *Plasmodium* parasite as shown in Figure 1. Use your oil-immersion objective since you must look inside the erythrocytes.
2. On the worksheet for this module, make drawings of as many stages as you find. The ring form is the most common stage. You will have to be a persistent microscopist to find other stages of the plasmodial parasite.

Some Platyhelminthic Infestations of Humans

Two phyla of worms are of medical significance because they contain genera that are parasitic in humans. Members of the phylum Platyhelminthes (flatworms) cause fluke and tapeworm infestation. Roundworms, which cause a variety of infestations, are placed in the phylum Nematoda. The collective term for all these parasitic worms is *helminths*, and the science that studies them is *helminthology*. Helminthology is a vast specialty in itself, and, once again, we will deal primarily with the medically significant organisms most frequently encountered in the United States. We will study the Chinese liver fluke *(Clonorchis sinensis)*, however, because it is probably the best-known fluke infestation of humans. Most fluke infestations seen in the United States occur in recent immigrants from areas of the world where they are more common, for example, the Orient or South America.

This module is limited to the flatworms, and the next module will describe the roundworms.

Helminths, which are metazoans (sometimes quite large), are studied in microbiology because diagnosis of helminthic infestations in the clinical laboratory is usually by microscopic examination of stool specimens, body fluids, or tissues (biopsy) for ova or larvae of the parasite (see Table 1).

TABLE 1 Summary of the Parasitic Platyhelminthes

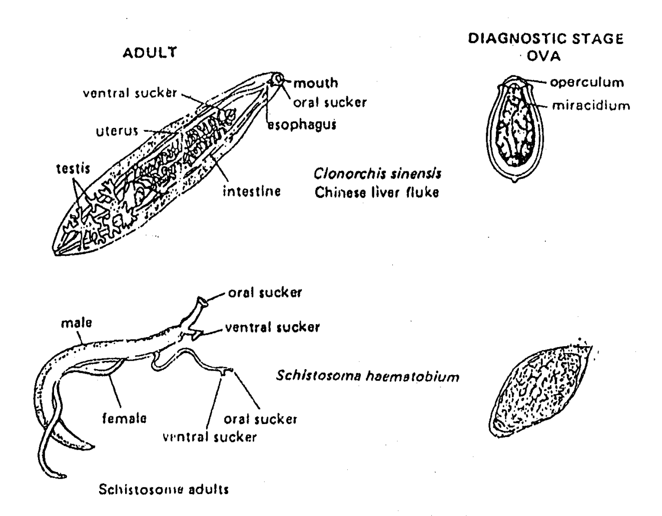
Parasite	Disease	Clinical symptoms	Diagnostic stage	Infective stage for humans
Clonorchis sinensis (liver fluke)	Chinese liver fluke infestation	Blocking of bile ducts, jaundice, cirrhosis	Ova in feces	Metacercaria in raw freshwater fish
Schistosoma mansoni *Schistosoma haematobium* (blood flukes)	Schistosomiasis	Spleen and liver enlargement, cirrhosis, schistosomal dysentery	Ova in feces	Free-swimming cercaria in fresh water penetrate skin and enter circulatory system.
Taenia saginata (beef tapeworm)	Beef tapeworm infestation	Diarrhea, increased appetite, intestinal obstruction	Ova or proglottids in feces	Cysticercus
Taenia solium (pork tapeworm)	Pork tapeworm infestation	Persistent diarrhea, serious complications with bladderworm encystment	Ova or proglottids in feces, surgical detection of bladderworm	Cysticercus or ova
Echinococcus granulosus	Hydatid disease or echinococcosis	Symptoms vary depending on location of cysts.	Precipitin, skin tests	Ova

The parasitic flatworms may be classified by the following simplified scheme:

Kingdom: Animal
  Phylum: Platyhelminthes—body flattened dorsoventrally, thin and soft.
    Class 1: Trematoda—flukes, all parasitic (liver flukes, blood flukes, lung flukes).
    Class 2: Cestoidea—tapeworms, all parasitic (beef tapeworm, pork tapeworm, fish tapeworm, hydatid worm).

The leaf-shaped trematodes are mostly *monoecious* (both sexes in one animal), but the schistosomes (blood flukes) are *dioecious;* that is, males and females are separate animals. Most trematodes have two suckers at the anterior end of the body for attachment to the host. The major portion of the body is occupied by the extensive reproductive system, as shown in Figure 1 .

Most fluke infestations are diagnosed from the characteristic ova in the feces of the parasitized host. One or two intermediate hosts may be required in the complex life cycles of the flukes. We will make no attempt to study life cycles in this module but rather will stress the effect of the parasite on the host. You may check any standard zoology textbook for details of the life cycle of any of the specific helminths if you are sufficiently interested.



Schistosoma mansoni



FIGURE 1
Some trematodes.

SCOLICES

suckers
neck
hooks
suckers
neck

PROGLOTTIDS

gravid uterus
genital pore
Taenia saginata
gravid uterus
genital pore
Taenia solium

Adult
Echinococcus granulosus

OVA

Taenia saginata or
Taenia solium or
Echinococcus granulosis
ovum (indistinguishable)

Cysticerci

scolex
scolex everted
scolex
scolex
suckers
top view
Taenia solium cysticerci
bladder worm

Immature scolex
Hydatid cyst containing numerous small protoscolices (hyatid sand)

FIGURE 2
Some cestodes.

difference between the life cycles of *Taenia solium* and *T. saginata* is that the ova of *T. solium* are infectious for humans, but the ova of *T. saginata* are not. Because it is not possible to distinguish ova of one species of *Taenia* from another, extraordinary care must be exercised by nurses and laboratory personnel when handling or disposing of feces from humans with *Taenia* infestations.

Human cysticercosis results from ingestion of the ova of *T. solium*. Once the ova hatch and the larvae penetrate the intestinal wall to the bloodstream, they encyst in striated muscle tissue, in subcutaneous sites, and sometimes in vital organs. Cysticercosis in humans or in swine is similar to the bladderworm condition in cattle (measly beef). However, the cysticerci of *T. solium* are much smaller than those of *T. saginata* and are not readily visible macroscopically. In human cysticercosis, the life cycle of *T. solium* is arrested at the bladderworm stage; that is, a human as the intermediate host is also the final host, unless cannibalized. The symptoms of cysticercosis depend on the location of the cysts. They can occur in the eye, brain, muscles, and visceral organs, but they have been reported most frequently in subcutaneous tissue.

The adult *Echinococcus granulosus* occurs in dogs, usually in great numbers, and is quite small—normally only three proglottids. The dog is usually infested by feeding on the viscera of another animal that is infested with the larvae of *E.*

granulosus. Dog feces contain the ova that, when ingested, are the infective stage for humans. Sheep, cattle, and occasionally humans serve as intermediate hosts for the larval stage. This larval stage is called the *hydatid cyst.* This cyst is the cause of hydatid disease, which is usually quite serious. Symptoms depend on the size and location of the hydatid cysts.

The hydatid cyst, often the size of a football, is a fluid-filled sac. Inside the cyst, buds form and grow into brood capsules where many immature scolices develop but are unable to mature. These immature scolices are called "hydatid sand." Thus in *E. granulosus,* multiplication occurs in both the adult and the larval stages. As the cyst enlarges, pressure and structural damage to surrounding tissues result. If the cyst ruptures, the contents extend to adjacent tissue, and new cysts form. In humans, the liver is the most common site of hydatid cysts, and the lung is the next most common.

Surgical excision of cysts that are in operable sites and have not extended too widely into surrounding tissues is the only relief for hydatid disease. Great care must be exercised to avoid puncturing the cysts and spilling the infectious contents into the surgical field.

ACTIVITIES

Activity 1: *Clonorchis sinensis*

1. Examine a prepared slide of the adult *Clonorchis* under your scanning lens or a dissecting microscope if available. Compare your prepared slide with Figure 1.
   - It is not necessary to locate all the structures that are labeled in the figure. It is more important that you will be able in the future to recognize and identify the parasite.
2. Make a sketch of what you see, and label it as fully as possible.
3. Examine a slide of *Clonorchis* ova under your high-power objective. Note the characteristic lid-like dome at one end of the ovum and the small knob at the other end.
4. Sketch what you see, and label it appropriately.
5. Write a brief description of the disease caused by *Clonorchis* infestations.

Activity 2: *Taenia saginata* (Beef Tapeworm)

1. Examine a slide of composite sections of *Taenia saginata* with a scanning lens or a dissecting microscope if available. Pay particular attention to the scolex and gravid proglottids. Refer to Figure 2.
2. Sketch what you see, and label it appropriately.
3. Examine preserved specimens of *T. saginata* if they are available.
4. Examine a slide of *T. saginata* ova under your high-power objective.
5. Make a sketch of the ova, and be able to recognize and identify them in the future.
   - Remember that tapeworm infestations are most often diagnosed by identification of the ova.
6. Write a short description of the disease caused by *T. saginata.*

Activity 3: *Taenia solium* (Pork Tapeworm)

1. Examine a slide of composite sections of *Taenia solium* carefully with a scanning lens or a dissecting microscope if available. Pay special attention to the scolex and gravid proglottids. Refer to Figure 2.
2. Sketch what you see, and label the structures that you are able to recognize.

3. Examine preserved specimens of *T. solium* and cysticerci if they are available.
4. Examine a cysticercus slide under low power.
5. Sketch what you see and label it.
6. Inspect a slide of *T. solium* ova with your high-power objective. You will note that they are indistinguishable from *T. saginata* ova as shown in Figure 2.
7. Write a short description of the diseases caused by *T. solium* infestations.

Activity 4: *Echinococcus granulosus* (Hydatid Disease)

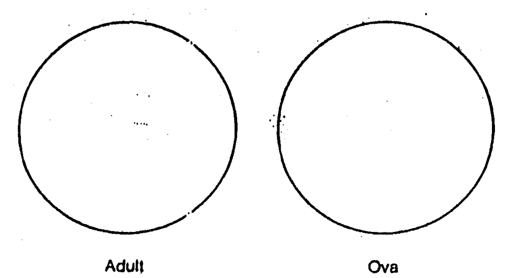
1. Examine slides and preserved specimens of *Echinococcus granulosus*, and make appropriately labeled sketches.
2. Write a short description of hydatid disease.

Name ______________________

Lab Section ______________________

SOME PLATYHELMINTHIC INFESTATIONS OF HUMANS

Activity 1
Clonorchis sinensis



Adult Ova

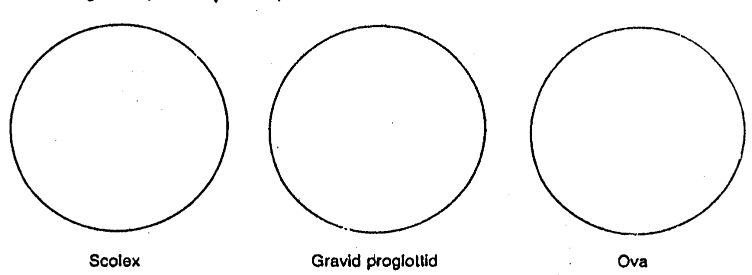
Describe disease caused by *C. sinensis*. ______________________

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Activity 2
Taenia saginata (Beef Tapeworm)



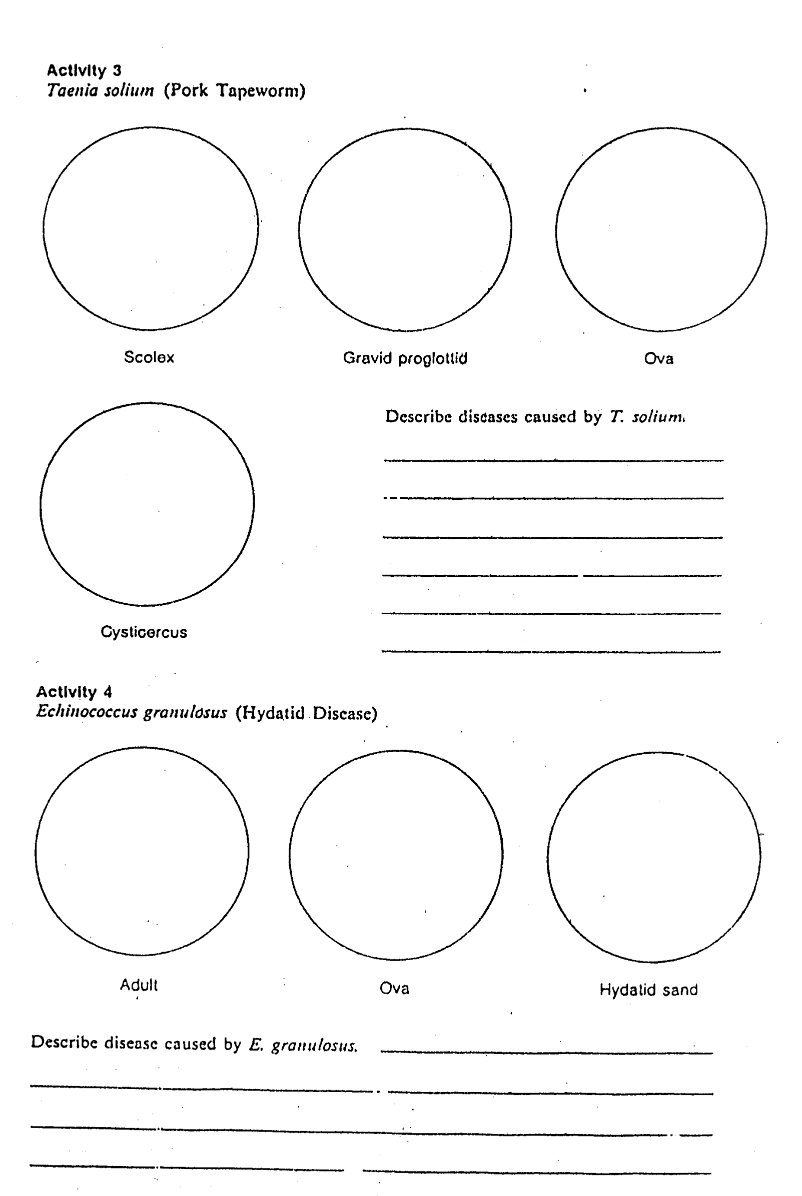
Scolex Gravid proglottid Ova

Describe disease caused by *T. saginata*. ______________________

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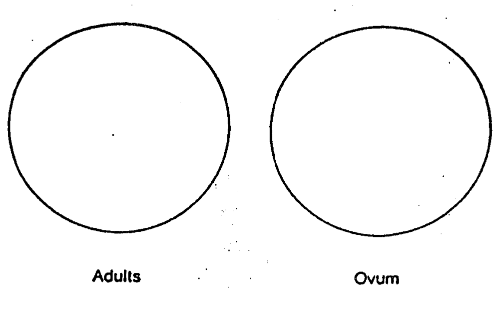


Activity 3
Taenia solium (Pork Tapeworm)

Describe diseases caused by *T. solium*.

Activity 4
Echinococcus granulosus (Hydatid Disease)

Describe disease caused by *E. granulosus*.



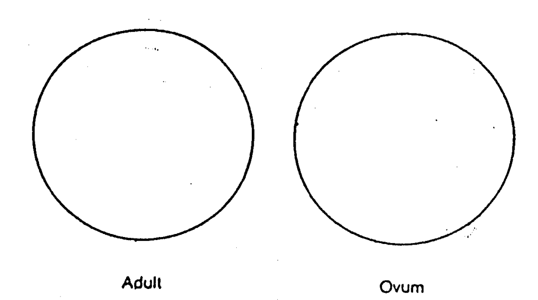
Fasciola hepatica ______________________________

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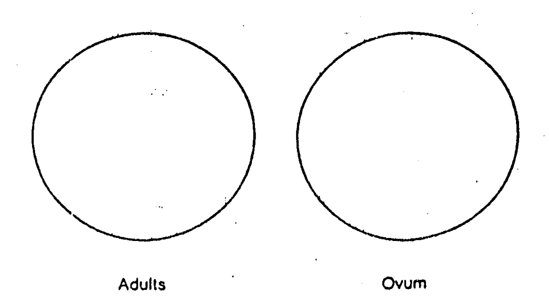
Activity 5



Fasciola gigantica ______________________________

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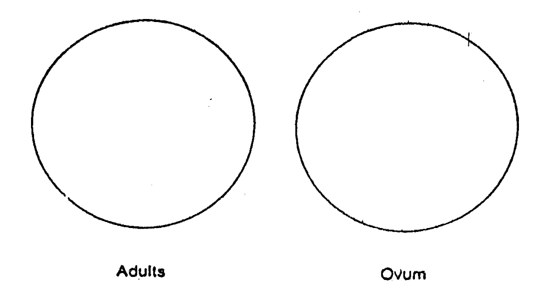


Heterophyes heterophyes

Activity 6

Adult

Ovum



Schistosoma haematobium ______________________

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Activity 7

Adult

Ovum

Schistosoma mansoni ______________________

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Some Nematode Infestations of Humans

The parasitic roundworms of humans are all in the phylum Nematoda. These animals are cylindrical in shape, have unsegmented bodies, and are tapered at each end. The body is covered by a tough layer of cuticle that protects the parasite from the gastric juices and enzymes of digestion in the intestinal tract of the host. Nematodes are dioecious, with the male usually smaller and more slender than the female. Males of most species are sharply curved at the posterior end of the body. Females produce large quantities of ova daily, a fact that is of great help to the clinician attempting to diagnose the infestation. The ova of the various genera that commonly parasitize humans are distinctly different and hence have much diagnostic significance. (Study Table 1 and Figure 1 regarding parasitic nematodes.) In fact, all infestations discussed in this module are diagnosed in the clinical laboratory from ova present in the patient's feces or on the perianal region, with the exception of trichinosis. *Trichinella spiralis* is a parasite of the tissues rather than of the intestinal tract and so must be detected by muscle biopsy and serologic tests.

TABLE 1 Some Parasitic Nematodes

Parasites	Disease	Clinical symptoms	Diagnostic stage	Source of infection
Enterobius vermicularis	Pinworm infestation	Pruritis ani, diarrhea, or none	Ova from perianal region by Graham's Scotch tape method	Ingestion of ova on hands and fomites (sing. fomes) or linens
Ascaris lumbricoides	Ascariasis	Allergic symptoms, abdominal pain or discomfort, intestinal blockage, vomiting, diarrhea, pneumonitis, fever	Ova in feces	Ingestion of embryonated ova in soil, often in contaminated water or food
Necator americanus	Hookworm disease	Pulmonary or intestinal pain, anemia, or none	Ova in feces; rarely, larvae in feces	Larvae in soil burrow into skin of bare feet
Trichuris trichiura	Trichuriasis or whipworm disease	Allergic symptoms or none	Ova in feces	Ingestion of embryonated ova in soil, often in contaminated water or food
Trichinella spiralis	Trichinosis	Mild gastrointestinal symptoms, painful respiration, heart muscle damage, muscle pain	Early infection, adults in feces; later, muscle biopsy and serologic tests	Ingestion of larvae in raw or undercooked pork or bear meat

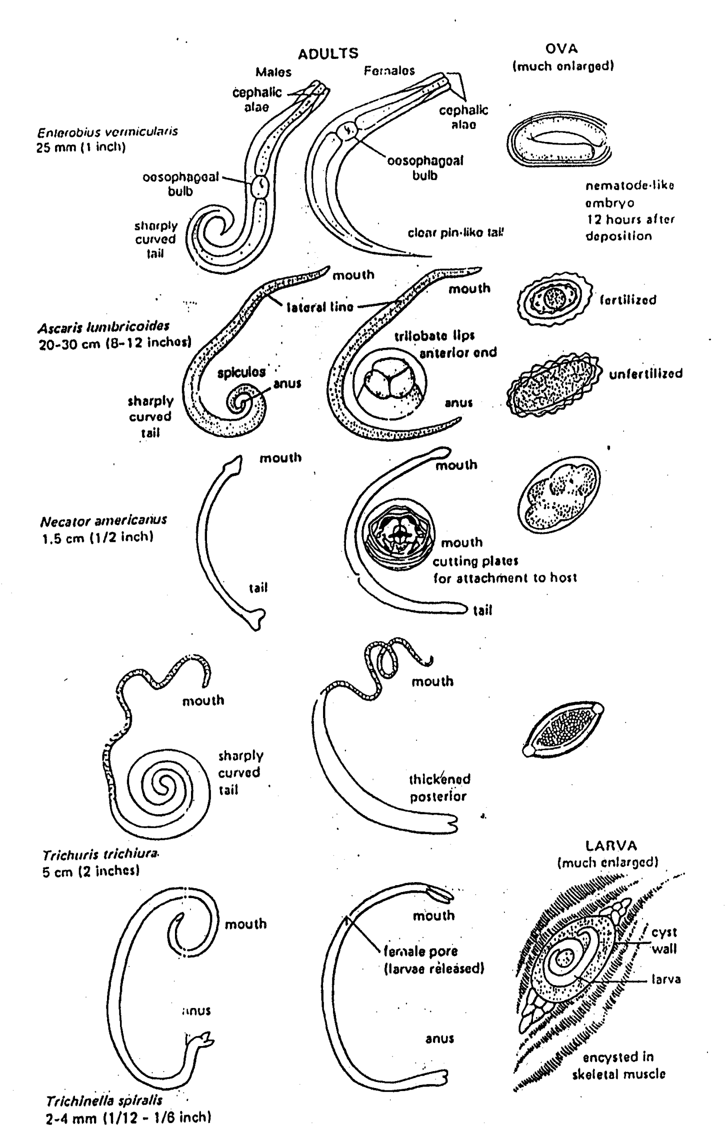


FIGURE 1
Some parasitic nematodes. See Figure 20-3 for size relationships of these nematodes.

ACTIVITIES

Activity 1: *Enterobius vermicularis* (Pinworm)

1. Examine a prepared slide of *Enterobius vermicularis* adults carefully under your scanning lens or dissecting microscope. Refer to Figure ..1 for comparison.
2. On the worksheet for this module, sketch what you see on the slide, and label the distinguishing features that you recognize.
3. Now examine a slide of *E. vermicularis* ova with your high-power objective.
4. Sketch what you see, and label it with the aid of Figure 1.
   - Since the ova are diagnostic, it is more important to recognize and identify them than the adults.
5. Write a brief description of pinworm infestation.

Activity 2: *Ascaris lumbricoides*

1. Obtain and examine a preserved adult ascarid worm.
   - Most preserved ascarids are recovered from swine and are somewhat larger than those found in human infestations.
   - Notice the trilobate lips at the anterior end of the animal.
2. Sketch the adult worm, and label its distinguishing features.
3. Examine a slide of *Ascaris* ova with your high-power objective.
4. Sketch representative ova, and be able to recognize them since they are clinically diagnostic.
5. Write a brief description of ascariasis.

Activity 3: *Necator americanus* (Hookworm)

1. Examine a prepared slide of a *Necator americanus* adult with your low-power objective.
2. Sketch an adult, and label only the readily distinguishable features.
3. Also examine a preserved specimen of *Necator* adults if available.

4. Now examine a slide of *N. americanus* ova with your high-power objective, and sketch an ovum.
   • Be able to recognize it because of its diagnostic value.
5. Write a brief description of hookworm infestation.

Activity 4: *Trichuris trichiura* (Whipworm)

1. Examine a prepared slide of *Trichuris trichiura* adults under your scanning lens or dissecting microscope.
2. Sketch an adult of either sex.
3. Examine preserved specimens of *Trichuris* adults if available.
4. Select a prepared slide of *T. trichiura* ova, and study it with your high-power objective.
5. Sketch a characteristic ovum.
   • Be able to recognize these ova since they are diagnostically important.
6. Write a brief description of whipworm infestation.

Activity 5: *Trichinella spiralis*

1. Examine a prepared slide of *Trichinella spiralis* adults with your low-power objective.
2. Sketch an adult worm of either sex.
3. Examine a prepared slide of *T. spiralis* larvae encysted in striated muscle tissue under your high-power objective.
4. Sketch what you see, and label the sketch as thoroughly as possible.
5. Write a brief description of trichinosis.

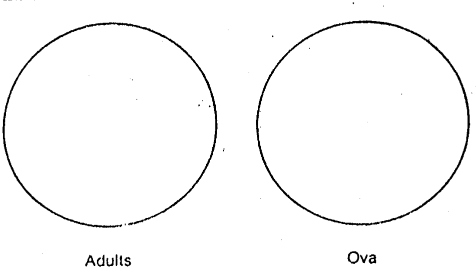
This module contains much information, so take the post test and then repeat any parts of the module necessary to enable you to achieve 100% on the post test.

Name ____________________

Lab Section ____________________

SOME NEMATODE INFESTATIONS OF HUMANS

Activity 1
Enterobius vermicularis **(Pinworm)**



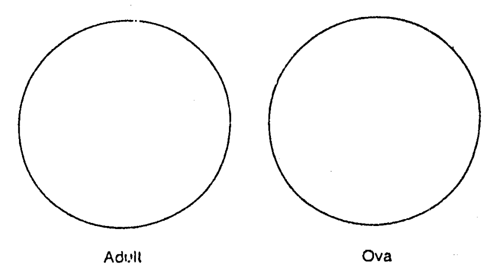
Describe pinworm infestation. ____________________

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Activity 2
Ascaris lumbricoides



Describe ascariasis. ____________________

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Activity 3
Necator americanus (Hookworm)

Adults

Ovum

Describe hookworm infestation. ______________________________

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Activity 4
Trichuris trichiura (Whipworm)

Adult

Ovum

Describe whipworm infestation. ______________________________

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DRUG THERAPY

The information in Table 1 is intended as general information about the types of drugs used to treat the more common parasitic infections. *Table 1 should not be used by physicians as a specific guide for treatment.*

TABLE 1. Primary Drugs of Choice for Parasitic Infections[a]

Organisms and Infections	Drug of Choice
Acanthamoeba spp.	See *Naegleria fowleri*
Ancylostoma duodenale	See Hookworms
Ascaris lumbricoides	Mebendazole or pyrantel pamoate
Babesia spp.	Clindamycin plus quinine
Balantidium coli	Tetracycline
Brugia malayi	See Filarial nematodes
Cestodes	
Adult or intestinal stage	Niclosamide
Larval stages in tissue	
Echinococcus granulosus	Surgery
Taenia solium	Praziquantel
Clonorchis sinensis	See Trematodes
Cutaneous larva migrans	Thiabendazole
Dientamoeba fragilis	Iodoquinol or tetracycline
Diphyllobothrium latum	See Cestodes
Dracunculus medinensis	Niridazole
Echinococcus spp.	See Cestodes
Entamoeba histolytica	
Intestinal disease	
Asymptomatic	Iodoquinol
Symptomatic	Metronidazole plus iodoquinol
Hepatic abscess	Metronidazole plus iodoquinol
Enterobius vermicularis	Pyrantel pamoate or mebendazole
Fasciola and *Fasciolopsis* spp.	See Trematodes
Filarial nematodes for *Onchocerca volvulus*	Diethylcarbamazine, suramin
Giardia lamblia	Quinacrine
Hookworms (*Ancylostoma duodenale* and *Necator americanus*)	Mebendazole or pyrantel pamoate
Hymenolepis spp.	See Cestodes
Leishmania spp.	Stibogluconate sodium
Loa loa	See Filarial nematodes
Naegleria fowleri	Amphotericin B
Necator americanus	See Hookworms
Onchocerca volvulus	See Filarial nematodes
Opisthorchis spp.	See Trematodes
Paragonimus westermani	See Trematodes
Plasmodium spp.	
P. vivax, ovale, malariae, or *falciparum* not resistant to chloroquine	
Suppression in endemic area	Chloroquine phosphate
Prevention after leaving endemic area (not required for *P. malariae* or *P. falciparum*)	Primaquine phosphate
Treatment of attack	
Uncomplicated	Chloroquine phosphate
Severe	Quinine dihydrochloride or chloroquine
Prevention of relapse (not required for *P. malariae* or *P. falciparum*)	Primaquine phosphate
P. falciparum resistant to chloroquine	
Suppression in endemic area	Pyrimethamine plus sulfadoxine
Treatment of attack	
Uncomplicated	Quinine sulfate plus pyrimethamine and sulfadiazine
Severe	Quinine dihydrochloride
Pneumocystis carinii	Trimethoprim-sulfamethoxazole
Schistosoma spp.	See Trematodes

TABLE 1. Primary Drugs of Choice for Parasitic Infections*—cont'd

Organisms and Infections	Drug of Choice
Strongyloides stercoralis	Thiabendazole
Taenia spp.	See Cestodes
Toxocara spp.	See Visceral larva migrans
Toxoplasma gondii	Pyramethamine plus trisulfapyrimidines
Trematodes	Praziquantel
Trichinella spiralis	Thiabendazole plus steroids
Trichomonas vaginalis	Metronidazole

TABLE 1. Primary Drugs of Choice for Parasitic Infections*—cont'd

Organisms and Infections	Drug of Choice
Trichostrongylus spp.	Thiabendazole
Trichuris trichiura	Mebendazole
Trypanosomiasis	
Trypanosoma cruzi	Nifurtimox
Trypanosoma brucei	
Blood-lymphatic stages	Suramin
Central nervous system stage	Melarsoprol
Visceral larva migrans	Diethylcarbamazine or thiabendazole
Wuchereria bancrofti	See Filarial nematodes

Modified from Med. Lett. Drugs Ther. 26:27, 1984.
* This table should not be used as a specific guide for treatment.

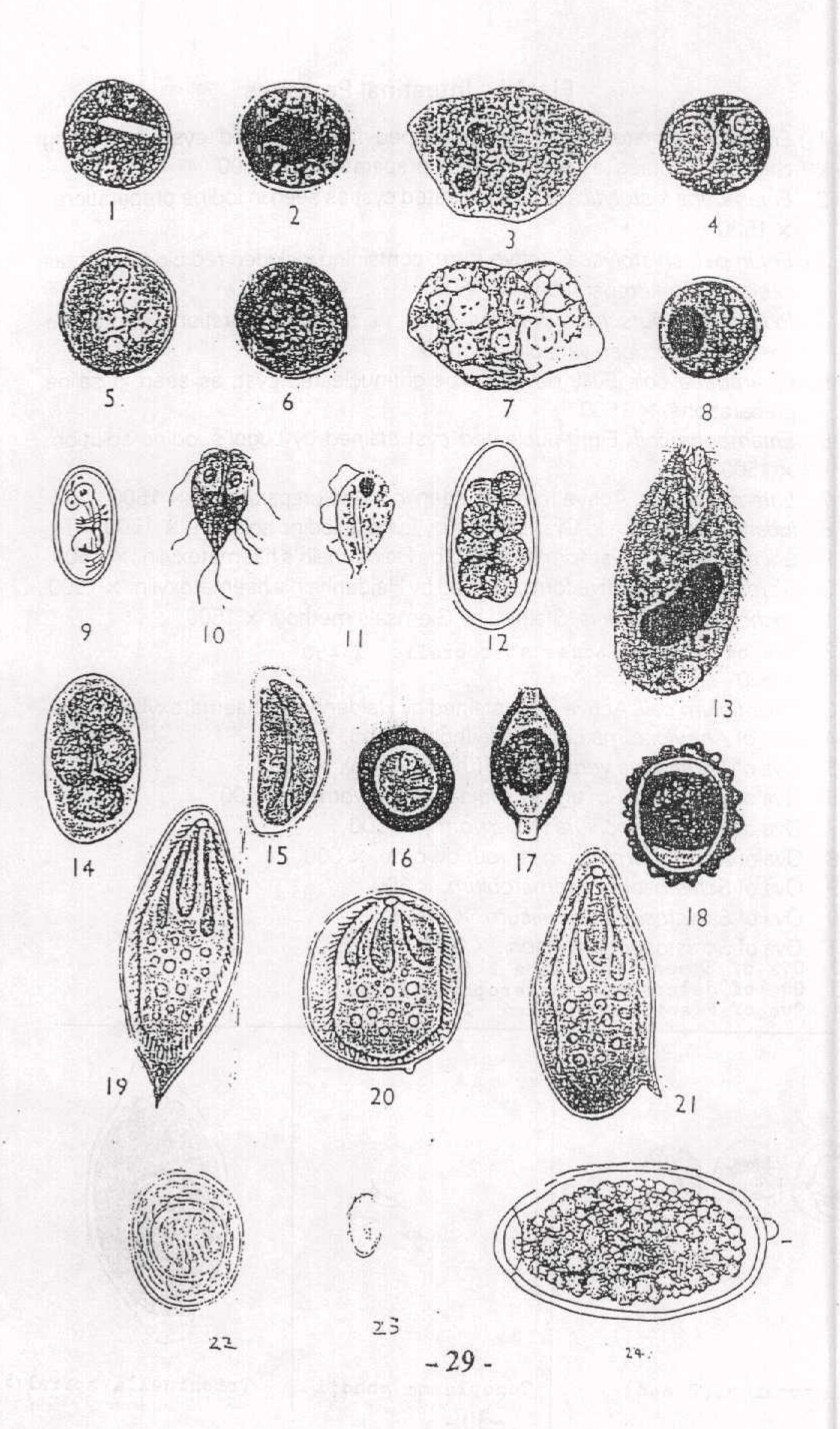
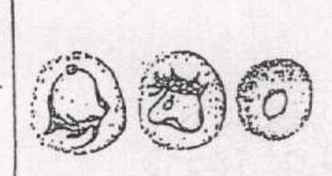

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Plate I Intestinal Parasites

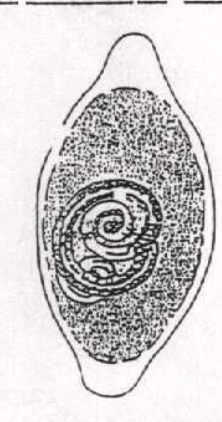
1 *Entamoeba histolytica*. Fully developed four-nucleated cyst, containing chromatid bodies, as seen in saline preparations. × 1500
2 *Entamoeba histolytica*. Four-nucleated cyst as seen in iodine preparation. × 1500
3 *Entamoeba histolytica*. Active form, containing included red blood cells; as seen in saline preparations. × 1500
4 *Iodamoeba bütschlii*. Cyst, as seen in saline preparations. Note the unstained glycogen vacuole. × 1500
5 *Entamoeba coli*. Fully developed eight-nucleated cyst, as seen in saline preparations. × 1500
6 *Entamoeba coli* Eight-nucleated cyst stained by Lugol's iodine solution. × 1500
7 *Entamoeba coli*. Active form, as seen in saline preparations. × 1500
8 *Iodamoeba bütschlii*. Cyst stained by Lugol's iodine solution. × 1500
9 *Giardia lamblia*. Cyst form, stained by Heidenhain's haematoxylin. × 1500
10 *Giardia lamblia*. Active form, stained by Heidenhain's haematoxylin. × 1500
11 *Trichomonas hominis*. Stained by Giemsa's method. × 1500
12 Ova of Strongyloides stercoralis X 450
× 500
13 *Balantidium coli*. Active form stained by Heidenhain's haematoxylin. × 350
14 Ova of *Ankylostoma duodenale* (hookworm). × 500
15 Ova of *Enterobius vermicularis* (threadworm). × 500
16 Ova of *Taenia solium* and *T. saginata* (tapeworms). × 500
17 Ova of *Trichuris trichiura* (whipworm). × 500
18 Ova of *Ascaris lumbricoides* (roundworm). × 500
19 Ova of *Schistosoma haematobium*. × 300
20 Ova of *Schistosoma japonicum*. × 300
21 Ova of *Schistosoma mansoni*. × 300
22 Ova of Hymenolepis nana X 600
23 Ova of Heterophyes heterophyes X 250
24 Ova of Fasciola hepatica X 300



Plasmodium (Blood)



Toxoplasma gondii



Trichinella spiralis

(3) General examination of feces for parasites:

Generally, two types of laboratories examine for parasites, the clinical laboratory in a hospital or doctor's clinic, and the public health laboratory. In the clinical laboratory, fresh samples may be examined for trophozoites, ova and cysts. Public health laboratories are usually located at a distance from the patients, and samples to be sent there, are usually unsuitable for examination of trophozoites by the time they arrive. To preserve larvae, ova and cysts and to render the specimens to be mailed to a distant laboratory, may be preserved in a variety of preservatives, as specified by the respective laboratory. Specimens may be collected in any sterile, clean, wide-mouthed container. A disposable waxed cardboard with an overlapping, tight-fitting lid is most suitable. These not only ensure a container that never has been used before but also permit handling and simple decontamination by incineration. For mailing specimens, a better choice is a screw-capped glass container filled one third with feces.

For simple, direct examination of stool specimens, use an applicator stick to emulsify enough stool in saline or water to obtain a murky suspension. Drop a cover glass over this preparation, ensure that the slide is dry at the bottom, and examine under low and high dry magnifications.

Cysts and eggs can often be seen best if dilute iodine is used instead of saline or water. Three preparations of three different areas of the specimens should be examined and all the slides screened carefully before reporting that no trophozoites, ova or cysts have been seen.

Several methods of concentration the ova and cysts present in a specimen have been developed. The zinc-sulfate flotation test and the formalin-ether centrifugation test are probably the most widely used tests. Zinc-sulfate is much safer to use than formalin-ether, and is more or equally sensitive in detecting clinically significant infections other than schistosomes. Only when suspecting schistosomes, therefore, should the formalinether mother be used.

3.1. Formalin-Ether centrifugation test:

1) Fill a conical-tipped 15 ml centrifuge tube half full with tap water.

2) Place at least 2 ml of feces in the water and mix well using a wooden applicator. Fill the tube to 10 mm. of the rim with additional water and mix well again.
3) Centrifuge at 1500 rpm for 2 min. Decant the supernatant fluid.
4) Add 10% formalin to the sediment until the tube is one-half full, mix thoroughly and allow to stand for 5 min.
5) Add about 3 ml. Ether (until tube is three-fourths full); stopper the tube (or use Parafilm) and shake vigorously; remove the stopper or parafilm carefully to prevent spraying of the material due to pressure within the tube.
6) Centrifuge at 1500 rpm for about 2 min. Four layers should result: a small amount of sediment containing most of the parasites; a layer of formalin; a plug of fecal debris on top of the formalin; and a topmost layer of ether.
7) Free the top plug of debris from the side of the tube by ringing with an applicator stock and carefully decant the three layers.
8) Mix the remaining sediment with the small amount of fluid that drains back from the sides of the tube. Drag sediment from tube onto a fecal slide by means of applicators. Prepare iodine mount of the sediment for microscopic examination.

3.2. Zinc-Sulfate flotation test:

1) Mix one part of formed stool with 10 parts warm water in a conical tipped 15-ml centrifuge tube.
2) Strain 10 ml of this mixture through muslin into a paper cup; and pour the suspension back into the same centrifuge tube. Fill with tape water.
3) Centrifuge this filtrate for 45-60 sec. At 2500 rpm.
4) Pour off the supernatant into a disinfectant, re-suspend the sediment in tap water, and centrifuge again; repeat until the supernatant is clear.
5) To the final sediment add 3-4 ml. 33% zinc sulfate solution (specific gravity 1.80). Mix thoroughly and then fill the tube to within 10 mm . of the rim with the same solution.
6) Centrifuge again for at least 90 sec.
7) Transfer material from the surface of the liquid to a glass slide by means of a loop, stir in a drop of dilute iodine solution, add a cover glass and examine under the low and high power of the microscope.

3.2. Objects likely to be mistaken for intestinal parasites:

One should realize, that many specimens, particularly stool specimens, may contain artifacts that might be mistaken for cysts, trophozoites, ova or even worms. Segmented strands of mucous may be mistaken for tapeworms. The same is true for banana fibres because of their segmented structure and oval cells. Fibres of celery and green vegetables may be mistaken for roundworms and orange fibres for pinworms. One should also differentiate between the intestinal parasites and the common artificats found in feces such as:

1) Molds; 2) Undigested muscle fibres; 3) Yeasts; 4) Oil droplets; 5) Plant epidermal gland cells; 6) Cotton fibres ; Blast cells of plant; 7) Pine; 8) Pollen grains; 9) Plant epidermal cells; 10) Vascular structures of plants; and 11) Plant epidermal hairs.

Serological Tests for diagnosis of parasitic infections:
1-Indirect Haemagglutination Test(IHA)

